COST EFFECTIVENESS APPROACH TO
B-1B CONSUMABLE AND REPARABLE
PROCUREMENT STRATEGIES

GRADUATE RESEARCH PAPER

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Abstract

The use of a cost effectiveness methodology to evaluate inventory procurement strategies can provide added insight into the best possible use of limited financial resources. This research utilized a cost effectiveness approach to evaluate the procurement of B-1B bomber spare parts used for base-level maintenance operations. The average number of backorders and average MICAP hours data for 32 Federal Supply Class (FSC) categories were drawn from an Arena simulation model based on historical supply and maintenance data from Ellsworth Air Force Base, along with corresponding cost data from the Air Force Total Ownership Cost database. With this data, the cost per average MICAP hour for each FSC was analyzed to gain insight into which FSCs are most likely to positively influence MICAP hour reductions in a cost effective manner.

An analysis of alternative procurement methodologies demonstrated the benefits of utilizing a strategy that targets incremental procurement of spare parts starting with the lowest cost per MICAP hour. This cost per MICAP hour approach provided the greatest benefit as a result of efficiently allocating resources (mainly appropriated funds) toward FSCs that have the greatest influence on MICAP hours. This approach provides an alternative method to execute funding in a cost effective manner with the added insight into how the execution of funding can improve the stockage of parts most likely to reduce MICAP hours and improve aircraft availability.

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To my wife for her continued love and support. Her patience and encouragement made this educational journey a rewarding experience.

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Ted A. Wahoske

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COST EFFECTIVENESS APPROACH TO B-1B CONSUMABLE AND REPARABLE PROCUREMENT STRATEGIES

I. Introduction

Background

The B-1B Bomber has persistently experienced low aircraft availability rates in recent years. One of the factors driving lower than desired availability rates is the persistent shortage of consumable and reparable parts, which has resulted in widespread mission capability (MICAP) hour challenges. A shortage of parts (MICAP) is one of the primary drivers leading to decreases in mission capable (MC) rates. MC rates in turn drive the number of mission capable aircraft available to execute a wings flying hour program. The aircraft availability (AA) rate indicates the percentage of the total active inventory (TAI) available to meet mission requirements, or $\left(\frac{MC\ Hours}{TAI\ Hours}\right) * 100$. Aircraft availability rates for the B-1B during fiscal year 2010 have averaged 32.2% (Table 1).

Table 1. Aircraft Availability

Weapon System	Oct 2009	Nov 2009	Dec 2009	Jan 2010	Feb 2010	Mar 2010
B-1B	32.04%	31.60%	34.24%	35.65%	28.15%	32.90%
Weapon System	Apr 2010	May 2010	Jun 2010	Jul 2010	Aug 2010	Sep 2010
B-1B	33.90%	29.59%	30.05%	33.74%	31.33%	32.77%

The Total Not Mission Capable for Supply (TNMCS) rate is a lagging indicator driven by the availability of spare parts and the number of airframes not available due to lack of parts, or $TNMCS = \frac{(NMCS\ Hours + NMCB\ Hours)}{Possessed\ Hours} * 100$, where NMCS Hours are the total hours across the fleet when an aircraft is not-mission capable due to supply and likewise, NMCB Hours are the total hours across the fleet when an aircraft is not-mission capable due to both maintenance and supply. Fleet refers to possessed aircraft and the Possessed Hours is the sum of the hours across the fleet. TNMCS rates averaged 16.7% over fiscal year 2010 falling short of the AFGLSC goal of 8% (Table 2). (Department of the Air Force, 2009)

Table 2. TNMCS rates

Weapon System	Oct 2009	Nov 2009	Dec 2009	Jan 2010	Feb 2010	Mar 2010
B-1B	17.5%	18.5%	14.6%	14.6%	17.4%	16.7%
Weapon System	Apr 2010	May 2010	Jun 2010	Jul 2010	Aug 2010	Sep 2010
B-1B	16.4%	19.7%	19.0%	13.9%	15.6%	16.9%

Understanding how a lack of spare parts drives MICAP hours and affects AA rates is important to the management of financial resources. Knowing the mix and depth of parts needed gives decision makers insight into which spare parts procurement efforts may assist decision makers in procurement strategies that help improve spare parts availability, lower total MICAP hours, and improve aircraft availability rates. A cost effectiveness approach is one method available to evaluate the number of alternatives.

One significant limitation surrounding any analytical proposal for implementation of greater efficiencies within the federal government is the cap on appropriated funds. In almost every case, any analysis of costs and benefits are constrained by current and programmed funding levels. While sensitivity analysis is necessary to understand how changes in funding effect the desired outcome, realistically, the most likely outcome(s) will depend on a zero-sum budget scenario. The military, as well as the federal government, can expect downward budgetary pressure for various reasons. Chief among these are the pressures brought on by the growth of entitlement programs such as Social Security, Medicare/Medicaid, and payment of the national debt. Mandatory entitlement programs such as these have grown over the last forty years from 23 percent of the federal budget to over 48 percent. In comparison, over this same period, the Department of Defense budget realized a similar change but in the opposite direction, from 43 percent to 20 percent. Additional factors that are limiting the growth of defense budgets include continuing operations in Iraq and Afghanistan and the recapitalization of forces and equipment from years of continuous contingency operations. (Brook and Candreva, 2009)

Pressures to limit budget growth and create operational efficiencies have put a renewed focus on executing budgetary resources efficiently rather than by way of the old standby of historical execution. As a way to entice federal agencies to embrace the concept of performance-based management, Congress passed the Chief Financial Officers Act of 1990 and the Government Performance and Results Act of 1993. The desired outcome from these pieces of legislation was to maximize the return on investment from funding appropriated and allocated by Congress. (Gawande and Wheeler, 1999)

In the spirit of embracing performance-based management, or more appropriately for the purpose of this discussion, performance-based-budgeting, this research seeks to provide insight into how to better allocate O&M funding for the procurement of B-1B bomber reparables and consumables.

Problem Statement

The purpose of this research is to investigate the most cost effective use of allocated appropriated operations and maintenance (O&M) funding for the procurement of B-1B bomber FSC stock levels.

Research Objectives

To understand how a cost effective approach may be beneficial to improving spare parts procurement strategies, this research effort has set forth the following research objectives:

- Determine the marginal (incremental) cost (increase in total cost) of procuring an additional unit of an FSC
- Determine the marginal (incremental) effectiveness (decrease in average MICAP hours) of procuring an additional unit of an FSC
- Determine the cost effectiveness (ratio) from an incremental change in an FSC backorder quantity

Through analysis of FSC cost data, backorder trends and average MICAP hour trends, the lowest calculated cost effectiveness ratios should provide additional insight into the most cost effective spare parts procurement alternatives.

Hypothesis

A necessary stepping-stone in calculating cost effectiveness is through the establishment of a cause and effect relationship between the number of backorders and the corresponding total MICAP hours for each FSC. In order to explore the sensitivity in changes to MICAP hours, the data must demonstrate a strong relationship between how many times an FSC is in a backorder status and the total time in backorder status for that FSC. Therefore, the following relationship between the number of backorders and total MICAP hours is hypothesized:

H1: A linear relationship exists between the number of FSCs backordered and total FSC MICAP hours

Limitations

This research project will limit the study to the 32 FSCs identified (Appendix C) in a previous MICAP hours study (Parson, 2010). The researcher collected cost data from the AFTOC database for the five-year period from January 2005 to December 2009.

Although the cost data provides classification of FSCs by GSD and MSD, the simulation model does not provide a similar level of detail because of the aggregate nature of the model. Additionally, the cost data from the AFTOC database itemizes each FSC by the individual parts. As with the GSD and MSD breakdown, the simulation model does not provide part detail below the FSC level.

Implications

The focus of this study is to offer a decision analysis tool that provides insight into alternative spare parts procurement strategies using a cost effectiveness approach for base-level supply and maintenance operations.

II. Literature Review

War on Lack of Parts

In May of 2010, the commander of the Air Force Global Logistics Support Center, Major General Gary McCoy, declared a War on the Lack of Parts (O'Brien, 2010). General McCoy made this declaration because of the Air Force's difficulty in supplying the necessary parts required to ensure depot maintenance activities continue unabated. Various root causes include misunderstood demand variance, repair and procurement constraints, supply chain performance, lack of resources (personnel, funding, and infrastructure), etc. (402nd SCMS/GUSB, 2010). While this initiative focuses on depot level maintenance, these root causes permeate base-level operations as well and degrade the ability of base-level operations to meet operational and maintenance mission requirements.

Balancing Operations and Maintenance Requirements

A flying wing's ability to achieve a required mission capability is a result of the combination of capacity and readiness of aircraft, personnel, equipment, facilities, and information. Part of the requirement to maximize mission capability involves balancing the requirements to train aircrews and test weapon systems and related tactics with the requirements to provide mission-ready aircraft, personnel, and equipment for both peacetime and wartime operational requirements. The ultimate success for any wing is how effectively it balances all of the above-mentioned requirements. The way in which the Air Force aims to achieve this balance is through the annual flying hour program. (Department of the Air Force, 2010)

The flying hour program (FHP) is central to attaining flying wing readiness and combat capability. The Air Force builds a FHP for each flying wing and mission design series. The FHP is an annual plan that allocates the programmed flying hours needed to adequately train aircrews and support the flying wings operational mission. In addition to flying hours, FHPs also include utilization (UTE) rates and the plan to execute allocated flying hours. (Department of the Air Force, 2010)

Air Force Instruction 21-101, Aircraft and Equipment Maintenance Management, directs maintenance organizations within flying wings to perform an annual capability assessment as part of the flying wing's FHP. In addition to assessing airframe factors effecting the execution of the FHP such as deployments, operational readiness inspections, programmed depot maintenance schedules, etc., the maintenance organization must also verify and analyze historical performance measurements. This analysis focuses on mission capable (MC) rates, break rates, fix rates, cannibalization rates, and attrition rates. (Department of the Air Force, 2010)

Flying and Maintenance Scheduling

The number one priority for the flying wings maintenance unit is the health of the fleet. Decisions regarding the maintenance actions are based on overall fleet readiness, fleet health, and operational requirements. Maintaining an effective and efficient fleet requires balancing scheduled and unscheduled maintenance against the wings flying schedule. Unbalanced maintenance schedules adversely affect availability of aircraft, which in turn result in diminished utilization rates and mission capable rates. (Department of the Air Force, 2010)

Performance Indicators

Performance indicators are necessary for monitoring the health of the fleet and assessing the quality of scheduled and unscheduled maintenance. An objective approach to indicators, or metrics, is critical to assessing the overall health of the fleet, and to assist managers in directing maintenance action toward the greatest need and improving fleet health, sortie generation, and overall operational performance. (Department of the Air Force, 2010)

The primary metrics used in assessing performance fall into leading and lagging indicator categories. Leading and lagging indicators help identify cause and effect relationships. Leading indicators are predictive, meaning they directly reflect maintenance's ability to provide operational aircraft for sortie production. Leading indicators (Appendix B) will provide decision makers with metrics data that show where to focus on improvement. Lagging indicators (Appendix B), however, show established trends and are useful for root cause analysis. The primary maintenance metrics for combat aircraft are fleet availability as measured by the mission capable (MC) rate and program execution as measured by the utilization (UTE) rate. (Department of the Air Force, 2010 and 2009)

In light of the heavy burden of fiscal constraints placed on the Department of Defense (DoD) and the continuing growth in costs of legacy weapon system sustainment, Air Force logisticians are under great pressure to change the method for allocating resources (Haines, 2010). Historically, the Air Force allocated resources based on desired combat effectiveness. Metrics such as the aforementioned MC rate drove this allocation process and fiscal limitations were not a factor during the planning stages

(Haines, 2010). However, given budget constraints, planners are now changing the allocation process by focusing on the most efficient allocation of resources. Aircraft availability (AA) now is the performance standard (or metric) that drives how funding is factored during weapon system sustainment requirements planning (Haines, 2010). Not Mission Capable Both (NMCB), Not Mission Capable Supply (NMCS), Not Mission Capable Maintenance (NMCM), unit possessed not reported (UPNR) and depot times all evaluate the overall health of the fleet and aircraft availability (Department of the Air Force, 2009).

Aircraft availability is based on total aircraft inventory (TAI) hours, that is, the percentage of a fleet's total active inventory available (MC) to accomplish programmed flying hours and mission requirements. The subcomponents that determine non-availability of an aircraft include UPNR, depot rate, NMCM, NMCS, and NMCB. (Department of the Air Force, 2009)

Of particular importance to predicting aircraft availability is the Code 3 Break Rate. The break rate is the percentage of sorties that land in a Code 3 status. Break rate is a leading indicator of aircraft reliability, quality of maintenance performed, and a predictor of required parts. The indicators influenced by break rate include MC, Total Not Mission Capable Supply (TNMCS), Cannibalization (CANN), and Repeat/Recur (R/R). Both MC and TNMCS have a direct bearing on the success of the AA rate. A low MC rate may indicate a trend in hard breaks or shortage of parts. TNMCS indicates the number of aircraft out for parts, rather than the number of parts in MICAP status. Further analysis of root causes of TNMCS will lead to a determination of which parts are indeed MICAP. (Department of the Air Force, 2009)

Arena Simulation Model

Discrete-event simulation was an approach used to investigate factors that influence TNMCS rates for B-1B bomber aircraft assigned to Ellsworth Air Force Base, South Dakota. This model, developed by Carl Parson, "tracked failed parts at the Federal Stock Class (FSC) level and their movement through the supply chain based upon probability distributions built using detailed historical data." This research investigated a number of factors at both the depot and base level to understand the effect on TNMCS rates for bomber aircraft at Ellsworth Air Force Base. Understanding factors that influence on-time delivery as well as the cost effective stocking and delivery of parts is one of the key factors in meeting programmed sortie rates and overall mission readiness. This research categorized parts within thirty-two FSCs that captured "80% of all supply requisitions as well as 83% of all MICAP hours in a five year period at Ellsworth." Using an experimental design approach, the analysis of results from the model pinpointed various factors that influence TNMCS rates as it relates to the B-1B bomber fleet. The factors identified included stockage effectiveness at the depot and base level, delays in sourcing parts from vendors, and the mean time between aircraft failures. Of particular interest was the significant influence various low-cost FSCs had on high TNMCS levels for the B-1B bomber. Quantifying the supply costs, which the model did not consider, might provide some insight into the optimal allocation of financial resources with the expected benefit of increasing mission capable rates for aircraft. (Parson, 2010)

Marginal Analysis

The marginal analysis approach compares the marginal benefits of a decision with the marginal costs to determine an optimal managerial decision (Baye, 2010). Stated another way, marginal analysis determines the improvement in a dependent variable that results from an additional unit and corresponding additional cost of an independent variable. It is beneficial to consume additional units as long as the benefits exceed the costs.

The two foundational calculations needed to conduct a marginal analysis include marginal benefits and marginal costs. Marginal benefit (MB) is the change in total monetary benefits arising from a change in the managerial control variable. Mathematically this equates to the total value of future benefits less the total value of current benefits or $MB = Total\ Benefit_{Future\ State} - Total\ Benefit_{Current\ State}$. Likewise, marginal cost (MC) is the change in total costs arising from a change in the managerial control variable. Mathematically, this equates to the future state cost less the current state cost, $MC = Cost_{Future\ State} - Cost_{Current\ State}$. Once the marginal benefits and costs are calculated, a marginal net benefit is derived by subtracting the marginal cost from the marginal benefit. The result is a change in net benefits that arise from a one-unit change in the managerial control variable. To maximum net benefits, increase the control variable until marginal benefits equal marginal costs. At this point, marginal net benefits are zero and no additional benefits are possible. (Baye, 2010)

Cost Effectiveness Analysis

One drawback of the marginal analysis approach discussed above is the need for quantitative monetary variables. When one or more variables studied are not monetary in nature, other approaches are necessary to determine additional benefits. Cost effectiveness analyses compare the current state (status quo) with a proposed future (alternative) state. One method for evaluating the outcome of a proposed alternative is through an incremental cost effectiveness ratio (Azimi and Welch, 1998). In essence, a cost effectiveness ratio is "a comparison of costs in monetary units with outcomes in quantitative non-monetary units" (NICHSR, 2008). The cost effectiveness ratio (CER) equates to the difference in total cost divided by the difference in effectiveness (Azimi and Welch, 1998):

$$CER = \frac{Total\ Cost_{Future\ State} - Total\ Cost_{Current\ State}}{Effect_{Future\ State} - Effect_{Current\ State}} \qquad (1)$$

This ratio expresses the cost of the additional outcome purchased by switching from the current state to the desired future state (ACP, 2011). Further, if the cost is low enough, the desired future state is considered cost-effective, however, a CER is relevant only if the desired future state is both more effective and more costly or both less effective and less costly (ACP, 2011). For this reason, a CER ratio requires a value judgment for it to be meaningful for decision-making (ACP, 2011).

Another approach to cost effectiveness involves assessing a reduction in risk in terms of cost versus the cost of implementing additional risk reduction methods, stated as $Cost/Benefit = \frac{Risk_{Baseline} - Risk_{Residual}}{Cost}$. This method requires an assessment of likelihood (probability of occurrence) and impact (associated cost) of various levels of risk. (Katsumata and others, 2010)

The Department of Defense adopted a cost effectiveness analysis model to evaluate engineering change proposals for aircraft engines. This approach takes a regularly occurring event, calculates the average cost per event, determines the number of events per year, then calculates the total cost each year. This approach is applied to both the current configuration and the change proposal. The impact of a change is determined by subtracting the current configuration costs from the change proposal costs. This methodology provides decision makers with data that assesses the value of changes and potential cost savings. (Dockendorf and others, 1996)

Normalizing Cost Data

When making cost comparisons across multiple years, it is important to adjust cost data for inflation by normalizing data from the current years to a base or constant year. Adjusting for inflation is necessary to normalize the data. The DoD Inflation Handbook defines inflation as “a sustained rise in the general price level, or the proportionate rate of increase in the general price level per unit of time”. From a macroeconomic perspective, inflation degrades our buying power over time. This adjustment of monetary values requires a conversion of current year dollars from one year to constant dollars in another year, which removes the effects of inflation to determine costs in constant dollar terms and facilitates comparisons across fiscal years. Current year dollars (then-year dollars) are the value of dollars used to make the transaction and constant year dollars (base year dollars) are directly comparable to current dollars for a given year. The equation for converting constant year to current year is:

$$\textit{Adjusted (Constant) Dollars} = \textit{Current Year Dollars} \left(\frac{\textit{Constant Year Weighted Index}}{\textit{Current Year Weighted Year Index}}\right) \tag{2}$$

Air Force inflation indices are developed and published by the Deputy Assistant Secretary of the Air Force, Cost and Economics (SAF/FMC) and are derived from guidance issued by the Office of the Secretary of Defense. These indices are used by the Deputy Assistant Secretary, Budget (SAF/FMB) and other agencies throughout the Air Force. (MCS, 2006)

III. Methodology

Data Sources and Format

Average MICAP hours and the number of backorders for each of the selected FSCs were generated using an Arena discrete event simulation model. The 32 FSCs of interest and the associated nomenclatures are included in Appendix C. These 32 FSCs represent roughly 80% of all spare parts sourcing actions that occur on a recurring basis. This model, created by Carl Parsons, investigated factors which affected TNMCS rates for the B-1B resulting from Code 3 landings of the aircraft. The model simulates the general supply flow for consumable and reparable spare parts for B-1B bomber aircraft assigned to Ellsworth AFB. Parts not in stock at base supply enter sourcing action from the Defense Logistics Agency (consumable parts), the relevant Air Logistics Center (reparable parts), or laterally from another base-level supply operation (reparable parts). If a part is not available at the depot or laterally, a backorder is created for that part, MICAP hours start accruing for that part, and the aircraft enters a non-mission capable status. (Parsons, 2010)

The Arena-based model generates data by way of twenty replications, each replication simulating sourcing action over a five-year period. Historical maintenance and supply data used to drive the simulation was supplied from the Logistics Installation and Mission Support-Enterprise View database and from subject matter experts. (Parsons, 2010)

From the raw data generated by the model, a lower bound (20th percentile), mean, and upper bound (80th percentile) statistical values were calculated. The 20th and 80th percentile bounds were selected because of the high occurrence of outliers in the raw data obtained from the discrete event simulation model. This wide range of data was due in part to the large number of different parts with varying backorder times for each FSC. A summary of FSC backorder and MICAP hour data from the Arena simulation model is found in Appendix D.

FSC cost data was collected from the Air Force Total Ownership Cost (AFTOC) database located at Ogden Air Logistics Center, Hill AFB, UT. Data of interest from the AFTOC database includes Funded Fiscal Period, Mission Design Cost Analysis Improvement Group (MD CAIG), Base, FSC, Total Charge Cost, and Total Charge Quantity. Cost data was collected in quarterly increments from January 2005 through December 2009. The raw cost data for each FSC was first converted to per unit figures by dividing the total charge cost by the total charge quantity for each quarter. From this per unit value, lower bound (20th percentile), mean, and upper bound (80th percentile) statistical values were selected due in part due to the large number of different parts with varying coats for each FSC; similar to our backorder/MICAP hour descriptive statistical calculations. Finally, current year cost values were converted to constant monetary values using base year fiscal year 2010 weighted indices. Weighted inflation indices, based on raw indices, for constant fiscal year 2010 are found in Appendix E, Table E1. The summary of FSC cost data, converted to constant year values, obtained from the AFTOC database is found in Appendix E, Table E2.

An examination of the unit cost data reveals distinct differentiation by dollar threshold (Figure 1). Appendix E, Table E2 provides the tabular unit cost data by FSC.

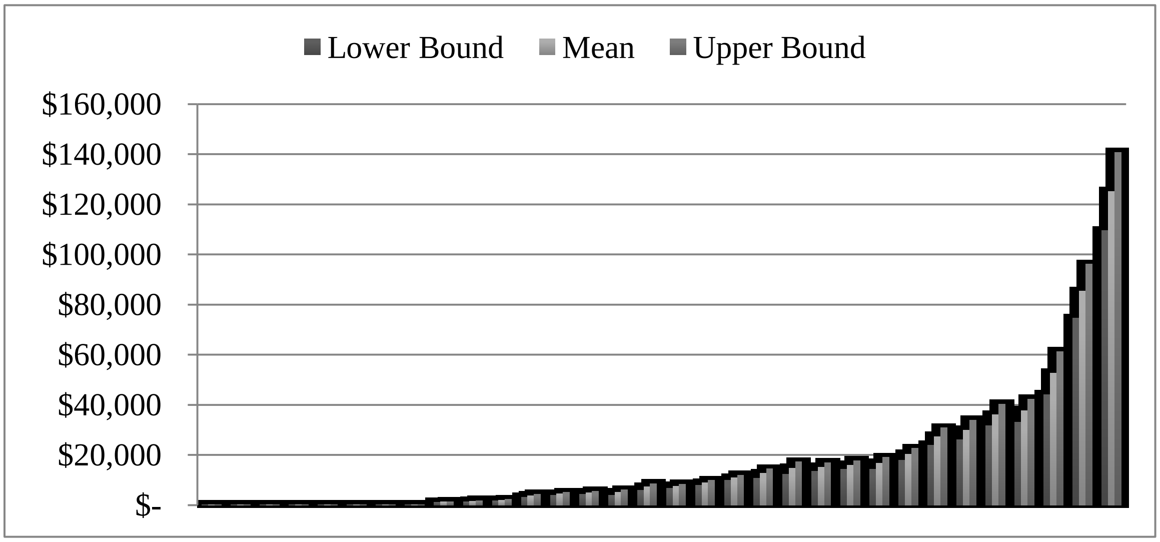

Figure 1. Unit Cost by FSC

Three groupings of unit cost data warrant closer examination, those FSCs with a unit cost below $200 per unit (Figure 2), between $200 and $10,000 per unit (Figure 3), and above $10,000 per unit (Figure 4).

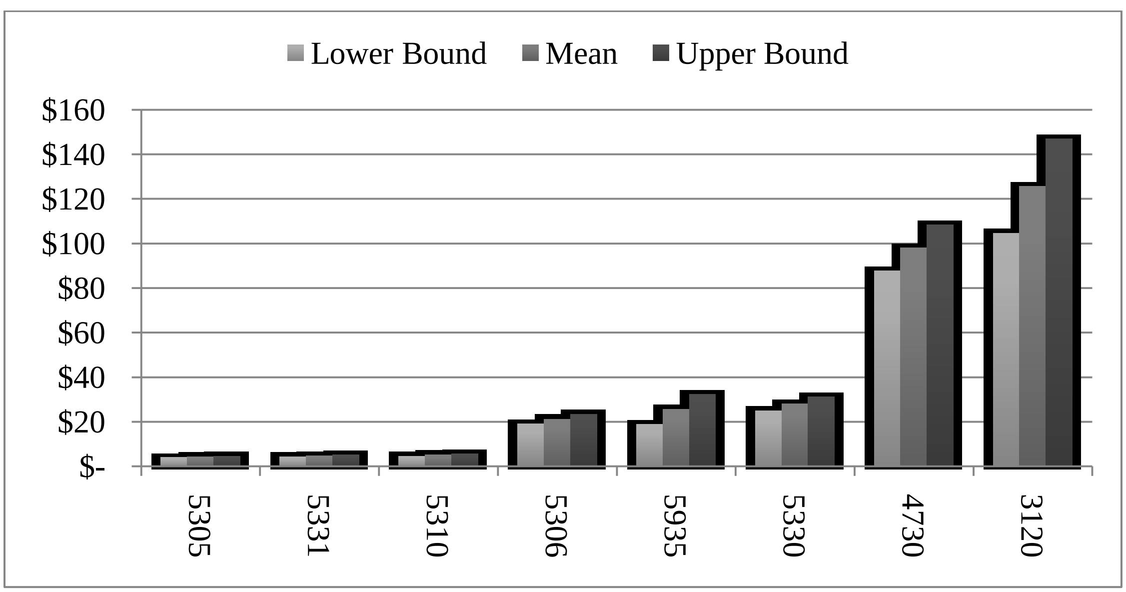

Figure 2. Unit Cost by FSC < $200

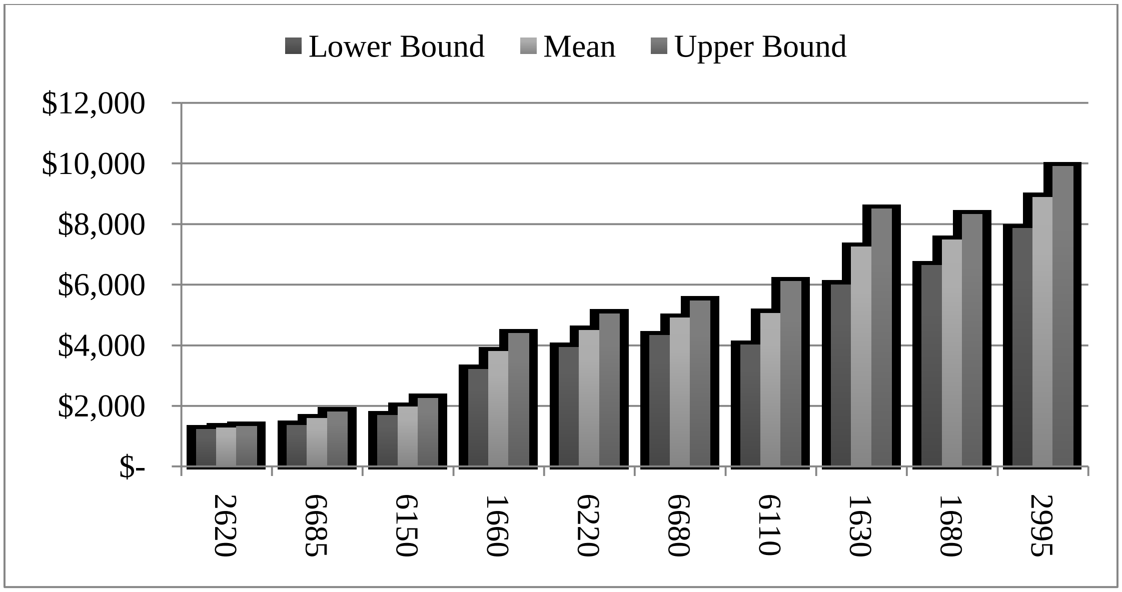

Figure 3. Unit Cost by FSC $200 <> $10,000

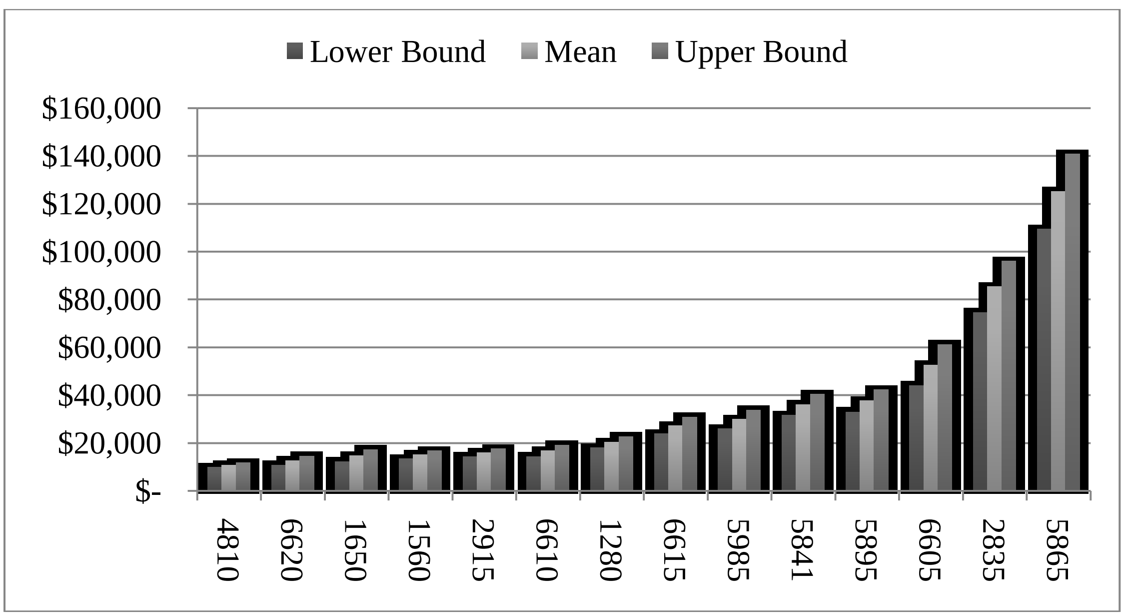

Figure 4. Unit Cost by FSC > $10,000

These three categories respectively, comprise 25 percent, 31 percent, and 41 percent of the total FSCs. Thus, a full 25 percent of the FSCs examined provide a means to increase spare parts stock levels at very low cost. This cursory examination provides us with strong possibilities for gains in efficiency through procurement efforts directed toward lower cost per unit FSCs.

Theoretical Model

Initially, a limitation existed in the ability to quantify the marginal benefit with the data available. The desired outcome of reducing MICAP hours (benefit) is obtained by a corresponding increase in the number of FSCs in stock, which in turn increases the total cost. The desired benefit of reduced MICAP hours is purely an effectiveness measure. Reducing MICAP hours reduces TNMCS rates, which in turn improve MC rates and AA rates, all of which improve the aircraft effectiveness and improve sortie generation rates. The better metric for classifying the desired outcome is by way of a cost effectiveness ratio. A key objective of this analysis is to reduce MICAP hours, which requires a corresponding reduction in the number of backordered FSCs. To reduce backordered FSCs requires additional funding to purchase additional stock. This funding must come by either increasing the baseline budget of the maintenance organization or a re-baselining of funding from another organization. The allocation or re-allocation of funding should be predicated by a decision that reducing MICAP hours to improve sortie generation is of greater value than the loss of funding and the corresponding degradation of mission effectiveness for the losing organization.

Hence, the preferred model used to generate the effectiveness of consumable and reparable procurement alternatives is the cost-effectiveness ratio (CER) given in equation (1). The defined cost is the total cost of each FSC used in the Arena simulation. Whereas the defined benefit is the total MICAP hours saved for each FSC on hand in the B-1B maintenance process. The managerial control variable, which influences or predicts corresponding changes in MICAP hours, is the number of backorders within an FSC.

The FSC future and current state cost figures are calculated as follows:

$$Cost = FSC\ Number\ Backordered * FSC\ Unit\ Cost \qquad (3)$$

The number of backorders for each of the FSCs is generated using the discrete event simulation model. The FSC current state effect (total MICAP hours) is also generated using the discrete event simulation model. An attempt is made to measure the FSC future state effects by way of a predictive model generated using simple linear regression. There is an assumed causal relationship between total MICAP hours by FSC (dependent variable) and number of backorders by FSC (independent variable). The establishment of this relationship and a corresponding predictive model allows us to quantify how sensitive changes in number of backorders are to the total time in MICAP status. The equation for this model is:

$$Total\ MICAP\ Hours\ by\ FSC = \alpha + \beta\ (Number\ of\ Backorders\ by\ FSC) \qquad (4)$$

The ensuing effectiveness ratio compares the cost of individual FSCs in monetary units with MICAP hour outcomes in quantitative non-monetary units. This ratio provides the cost per change in effect, namely, the additive cost associated with an improvement (reduction) in MICAP hours. Since the outcome of this ratio results in higher cost for lower efficiency, ultimately, the decision maker must make a determination of how much funding to allocate toward those changes that produce the desired effect; namely, an increase in spare parts availability, a reduction in MICAP hours and the corresponding reduction in TNMCS rates and improved AA rates.

IV. Results and Analysis

Regression Results

Simple linear regression was used for testing the hypothesized relationship between the dependent and independent variables as summarized in Table 3.

Analysis of Data

Overall, the regression of the data presented unexpected results. Even though, in general, there is a significant linear relationship among the 32 FSCs ($p < .01$) indicating the beta values are statistically different from zero, the coefficient of determination across all FSC is unacceptably low. The coefficient of determination (R^2) across all 32 FSC ranged from a minimum of 0.0083 for FSC 1560 to a maximum of 1.0000 for FSC 1680 with an overall FSC mean value of 0.3171 across all FSCs. On average, the model explains only 32 percent of the variation in dependent variable. Therefore, the conclusion resulting from the regression is that although the linear relationship between the dependent variable and the independent variable is statistically significantly, the regression model does not provide the meaningful relationship needed to predict changes in the dependent variable except for a small number of the FSCs examined.

Upon further examination of the discrete-event simulation model developed within Arena, it was determined that certain limitations exist as it relates to the hypothesis. The predictability and validation of model outcomes is limited to the macro view of spare parts procurement. In addition, the large number of parts within individual FSCs as well as the wide-range of backorder times resulted in a large range of outcomes. In its current construct, because of the absence of a relationship between total MICAP hours by FSC and number of backorders by FSC, the model is limited in its ability to provide predictive outcomes at the individual FSC level.

Table 3. Regression Analysis Results

FSC	Slope (β_1)	Intercept (β_0)	Coefficient of Correlation (r)	Coefficient of Determination (r^2)	t-statistic	p-value
1280	122.316	151.031	0.262	0.069	2.692	0.008
1560	89.708	2,222.059	0.091	0.008	0.905	0.368
1630	161.123	(686.066	0.335	0.112	3.515	0.001
1650	187.166	(107.891	0.707	0.500	9.906	0.000
1660	138.761	(48.293)	0.412	0.170	4.473	0.000
1680	54.000	0.000	1.000	1.000	4.698	0.000
2620	197.312	(0.529	0.747	0.558	11.117	0.000
2835	164.327	91.987	0.635	0.404	8.144	0.000
2915	187.557	6.229	0.843	0.711	15.544	0.000
2995	183.655	(310.755)	0.515	0.265	5.951	0.000
3120	157.845	1,550.715	0.562	0.316	6.722	0.000
4730	109.479	289.336	0.217	0.047	2.198	0.030
4810	209.479	(48.154)	0.810	0.656	13.660	0.000
5305	207.412	(2.584)	0.817	0.668	14.031	0.000
5306	224.021	(435.909)	0.584	0.342	7.129	0.000
5310	166.235	(218.757)	0.504	0.254	5.783	0.000
5330	214.210	(527.638)	0.511	0.262	5.892	0.000
5331	198.646	88.791	0.746	0.556	11.087	0.000
5841	101.356	890.408	0.216	0.047	2.188	0.031
5865	110.573	789.746	0.261	0.068	2.674	0.009
5895	187.950	180.102	0.707	0.500	9.905	0.000
5935	115.839	2.601	0.399	0.159	4.302	0.000
5985	146.737	(125.542)	0.406	0.165	4.401	0.000
6110	153.647	(77.907)	0.206	0.042	2.084	0.040
6150	187.746	3.970	0.803	0.644	13.318	0.000
6220	206.401	(146.800)	0.558	0.311	6.652	0.000
6605	194.836	5.569	0.765	0.585	11.743	0.000
6610	81.964	1,604.951	0.227	0.052	2.309	0.023
6615	205.159	(1,529.930)	0.434	0.188	4.768	0.000
6620	156.172	(189.521)	0.349	0.122	3.687	0.000
6680	149.975	(170.489)	0.401	0.161	4.337	0.000
6685	170.957	(208.308)	0.455	0.207	5.056	0.000

Exploratory Model Development

Since a statistically significant relationship between the dependent and independent variables is not available, it is necessary to re-evaluate the cost effectiveness model. The CER as presented calculates a ratio of inputs to outputs, inputs being the cost of parts and outputs being total MICAP hours. This provides the decision maker with a method to evaluate how well they are using their resources to lower MICAP hours. Even without the ability to calculate a change in output, the model still provides value. Dropping the "future state" variables from the model leave us with:

$$Cost\ per\ MICAP\ Hour\ by\ FSC = \frac{Average\ Unit\ Cost\ by\ FSC}{Average\ MICAP\ Hour\ by\ FSC} \tag{5}$$

This method demonstrates the impact of optimizing additional expenditures through the calculation of a cost per unit. Utilizing average MICAP hours by FSC and average unit cost data by FSC allows for the calculation of a cost per MICAP hour for each FSC. By calculating the cost per average MICAP hour, a rank order of FSCs by lowest to highest cost per MICAP hour is attained.

As with unit cost, the cost per MICAP hour maintains a similar relationship, and we can define three groupings by cost threshold. The three categories are those FSCs with a mean average cost per MICAP hour below $1 (Figure 5), between $1 and $100 per average MICAP hour (Figure 6), and above $100 per average MICAP hour (Figure 7). Inherent to these three figures is a relationship whereby the average cost per MICAP hour decreases incrementally from the lower bound to the upper bound numbers. This relationship occurs when given an average cost by FSC, the average cost per MICAP hour decreases when the corresponding average number of MICAP hours increase.

The three categories respectively comprise 25 percent (same FSCs as in the lowest unit cost group), 44 percent, and 31 percent of the total FSCs. Thus, as before, a full 25 percent of the FSCs examined provide a means to increase spare parts stock levels at very low cost. During the process of converting FSC cost data from a per unit figure to a per average MICAP hour figure, there was minimal movement between the three groupings. Those FSCs that did shift involved costs in the $7,000 to $16,000 unit cost range and the $50 to $140 cost per average MICAP hour range and migrated from the mid range to the high range and vice versa (Appendix F). This movement among the mid and high range groupings is of less concern since the highest impact on average MICAP hours are those FSCs identified in the low range.

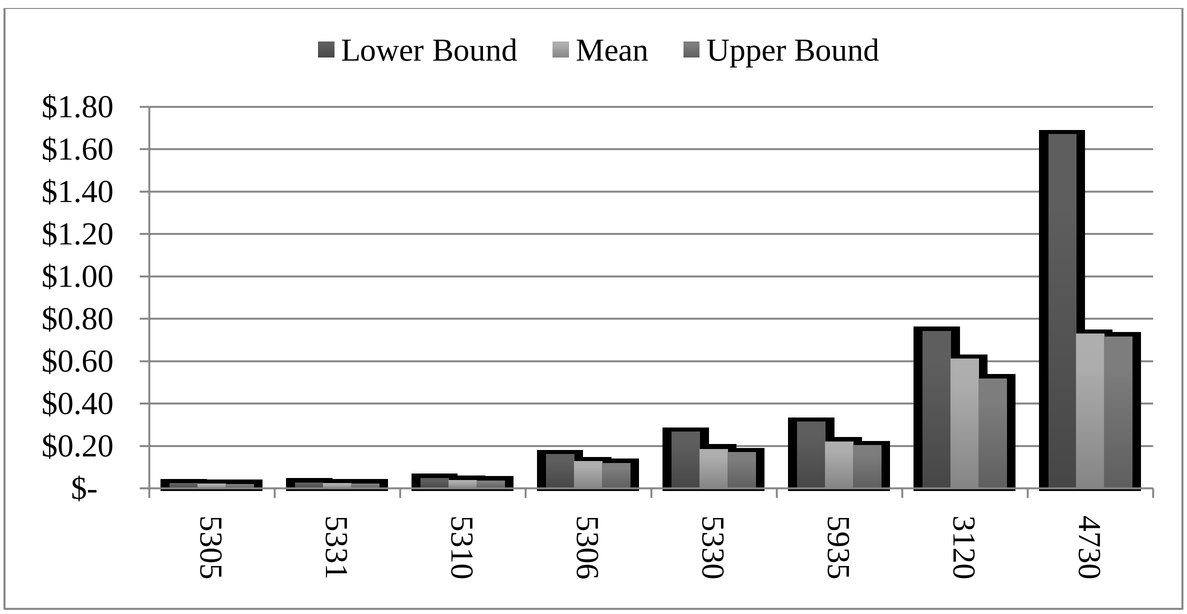

Figure 5. Avg Cost per MICAP Hour < $1

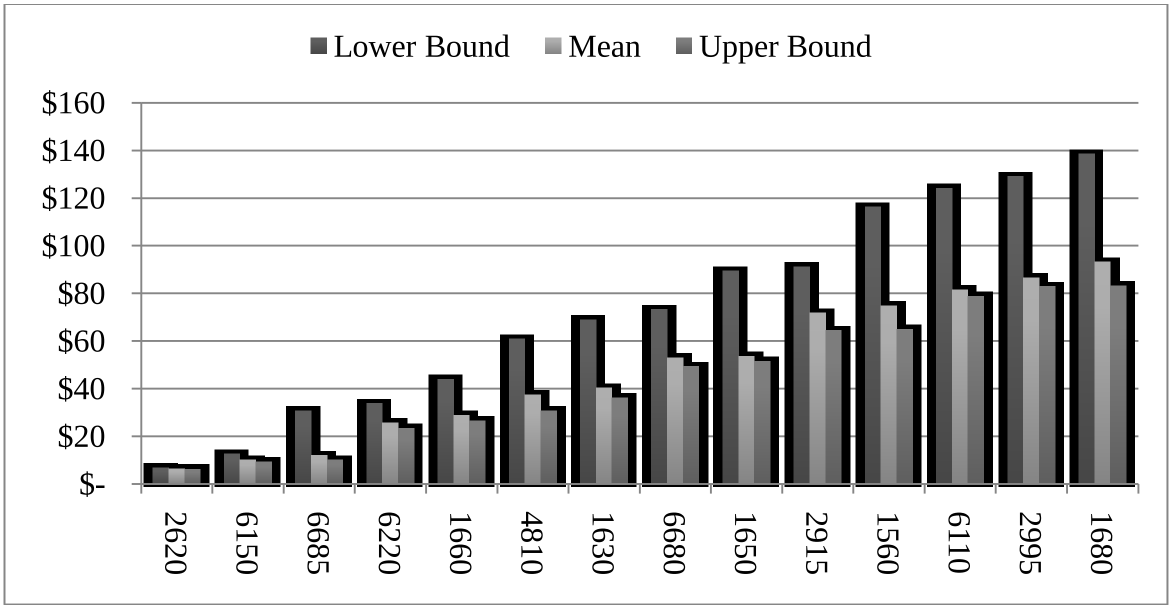

Figure 6. Avg Cost per MICAP Hour $1 <> $100

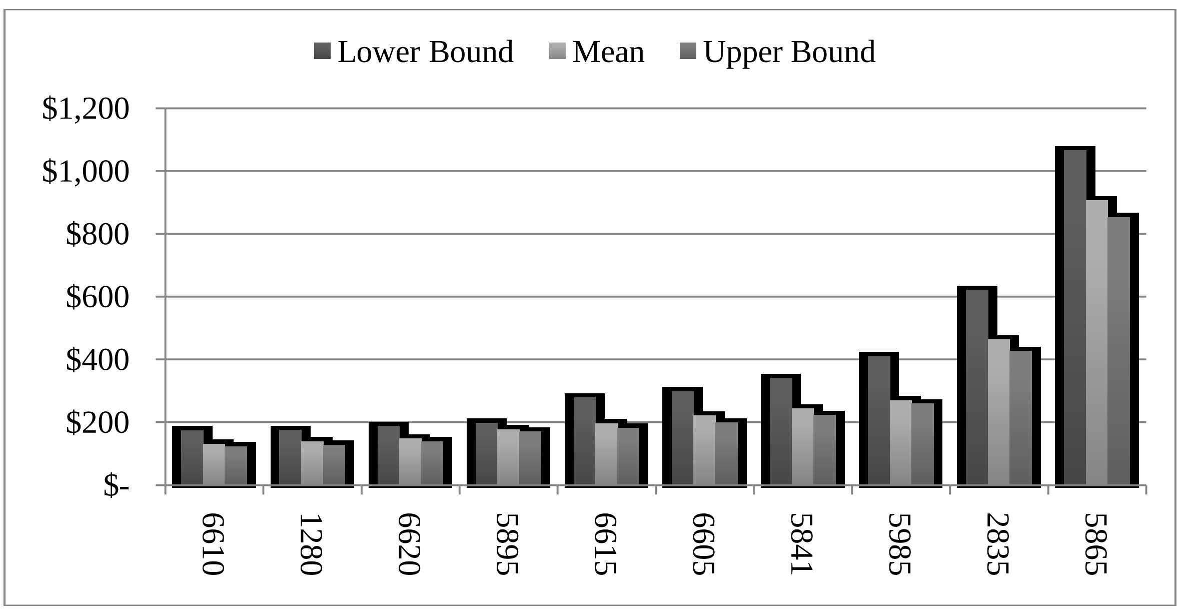

Figure 7. Avg Cost per MICAP Hour > $100

Coupled with the fact that FSCs at a lower cost per MICAP hour rate consume less capital than higher cost FSCs, from a funding execution standpoint, it is beneficial to focus procurement efforts on low cost FSCs. However, increases in procurement are only meaningful up to a reasonable demand for each FSC, which we define as the mean number of backorders. Any amount ordered above this number only increases inventory levels beyond that which is routinely required for maintenance and supply and unnecessarily increases inventory holding costs. Based on an arbitrary increase in funding of five hundred thousand dollars, Table 4 outlines the procurement order strategy and the theoretical MICAP hours saved. Procurement costs are derived as follows:

$$Procurement\ Cost = Not\ to\ Exceed\ Mean\ Number\ Backorders * Average\ Unit\ Cost \quad (6)$$

Saved MICAP hours are derived as follows:

$$Saved\ MICAP\ Hours = \frac{\Pr ocurement\ Cost}{Cost\ Per\ MICAP\ Hour} \quad (7)$$

Table 4 – Rank Ordered Procurement

FSC	Cost per MICAP Hour	Number of Backorders	Order Quantity	Procurement Cost	Saved MICAP Hours
	(Mean)	**(Mean)**	**(Mean)**	**(Mean)**	**(Mean)**
5305	$0.02	10	10	$43.44	2,073
5331	$0.02	11	11	$52.99	2,284
5310	$0.04	9	9	$47.11	1,264
5306	$0.13	8	8	$170.28	1,342
5330	$0.19	10	10	$279.29	1,509
5935	$0.22	10	10	$250.88	1,138
4730	$0.61	7	7	$640.13	1,049
3120	$0.73	105	105	$13,207.42	18,137
2620	$6.47	13	13	$16,650.96	2,575
6150	$10.07	6	6	$11,426.22	1,135
6685	$11.95	6	6	$9,445.86	790
6220	$25.62	6	6	$26,950.66	1,052
1660	$28.93	9	9	$34,220.56	1,183
6110	$37.51	6	6	$30,383.95	810
6680	$40.36	7	7	$34,331.14	851
1630	$53.03	29	29	$210,162.93	3,963
4810	$53.64	8	8	$82,054.99	1,530
2995	$71.80	6	3	$26,656.92	371
1560	$74.88	21		$ -	-
1650	$81.48	18		$ -	-
2915	$86.62	5		$ -	-
6620	$93.20	11		$ -	-
6610	$129.82	35		$ -	-
1680	$138.55	48		$ -	-
1280	$147.12	10		$ -	-
5895	$176.53	8		$ -	-
6615	$195.91	25		$ -	-
5985	$220.99	11		$ -	-
5841	$243.11	20		$ -	-
6605	$268.94	8		$ -	-
2835	$462.97	5		$ -	-
5865	$906.32	30		$ -	-
		Total	**263**	**$496,975.74**	**43,056**

Analysis of Exploratory Model Results

This approach is characterized by the concept of diminishing marginal returns, that is, the allocation of resources toward those efforts that produce the greatest payoff should be executed first (Thompson, 1993). As it applies to categorizing alternatives by a cost factor, if additional O&M funding is available through budget reprogramming action, these budget dollars should be used to purchase FSC items with the lowest cost per MICAP hour first, and continue the procurement of subsequent and higher cost per MICAP hour FSCs until available funding is exhausted. This approach provides the decision maker with insight into which FSCs have the greatest impact on reducing average MICAP hours at the lowest cost. Given that the number of available aircraft drives TNMCS and AA rates, a reduction in MICAP hours for parts may not directly translate into a corresponding improvement in TNMCS and AA since an aircraft is typically waiting for multiple parts. However, this approach should still have an impact on improving the availability of parts and an increase in AA.

V. Conclusions

Research Summary

This research developed a decision making tool to study how a cost effectiveness approach to procurement, based on the cost of a federal supply class per MICAP hour, can evaluate alternative strategies to reducing B-1B MICAP hour rates and improving B-1B mission readiness and availability. Our initial approach required some modifications to best use data provided by the Arena simulation to support the objectives and hypothesis of the study. The resulting methodology to evaluate cost effectiveness provides constructive insight into how a deliberate procurement approach can positively influence MICAP hour reductions in a cost effective manner.

By comparing the diminishing marginal returns approach with alternative procurement strategies, we see the benefit this methodology provides. The summary data from Table 4 (order quantity, procurement cost, and saved MICAP hours) is compared with matching data for two competing procurement strategies. The three approaches comprise 1) the original rank ordered procurement strategy with a funding ceiling of $500K, 2) a uniform distribution of a fixed quantity across all 32 FSCs, and 3) separate, diminishing fixed quantities applied to each grouping (Table 5). The quantities applied to each group under the third alternative are as follows: order quantity of 14 for FSCs with an average cost per MICAP hour of less than $1, order quantity of 8 for FSCs with an average cost per MICAP hour between $1 and $100, and order quantity of 4 for FSCs with an average cost per MICAP hour above $100. The two competing procurement strategies are capped to approximately match the total order quantity of the original approach to allow a comparison of total procurement cost and total saved MICAP hours.

Table 5. Analysis of Alternate Procurement Strategies

	Order Quantity	Procurement Cost	Saved MICAP Hours
Rank	263	$496,975.74	43,056
Uniform	256	$4,012,143.04	37,373
Tiered	264	$2,527,378.55	34,927

This analysis of alternatives demonstrates the benefits of utilizing a strategy that targets incremental procurement of spare parts starting with the lowest cost per MICAP hour. Such an approach capitalizes on the most efficient use of scare resources (mainly appropriated funds) by targeting FSCs that have the greatest influence on MICAP hours at the least cost.

The main caveat is that this is a decision making tool and it does not draw a direct link between an orderly purchasing strategy and a reduction in B-1B MICAP hours. Any insight provided by the analysis must be weighed against other competing procurement and funding priorities and strategies. This model simply provides an alternative method to execute funding in a cost effective manner with the added insight into how the execution of funding can improve the stockage of parts most likely to reduce MICAP hours and improve aircraft availability.

Areas of Further Study

Tacking the limitations of this study can provide areas for further research. A worthwhile area of study that would produce greater clarity is through categorizing FSCs by data type (GSD and MSD) and itemizing spare parts at the sub-FSC level. Modifying the simulation model to differentiate by data type and itemize parts at the sub-FSC level would allow greater insight into which spare parts have a greater influence on total MICAP hours. Cost data from the AFTOC database is configured to provide detail by data type and the itemization of spare parts by sub-FSC

Appendix A: Definitions

Air Force Total Ownership Cost (AFTOC): An Air Force database that provides routine, timely visibility into almost all AF costs. AFTOC includes all major Air Force systems, all appropriations and Major Commands, crosses cost-logistics data boundaries, and provides permanent archive of cost and logistics data (AFTOC, 2008).

Cannibalization (CANN): Authorized removals of a specific assembly, subassembly, or part from one weapons system, system, support system, or equipment end-item for installation on another end-item to meet priority mission requirements with an obligation to replace the removed item.

Code 3: Aircraft has major discrepancies in mission-essential equipment that may require repair or replacement prior to further mission tasking.

Federal Supply Class (FSC): Groups items in broad categories (AFTOC, 2008).

Funded Fiscal Period: Concatenated year and quarter identifying the fiscal year to which the transaction applies – a DOD fiscal year beginning on 1 October and ending on 30 September the following year (AFTOC, 2008).

General Support Division (GSD) Items: Consumable goods; bench stock used for replenishment.

Maintenance Capability (MC): The capacity of a maintenance organization, as driven by resource availability, to train personnel and service, inspect, repair and generate aircraft/missiles, equipment, munitions or other commodities.

Material Support Division (MSD) Items: Durable goods; high dollar equipment items.

Mission Impaired Capability Awaiting Parts (MICAP): Parts and equipment sourced to repair not mission capable aircraft (AFLMA, 2010).

Mission Design - Cost Analysis Improvement Group (MD CAIG): The Mission Design used by the Cost Analysis Improvement Group (CAIG) process in AFTOC (AFTOC, 2008).

Mission Design Series (MDS): Alpha and numeric characters denoting primary mission and model of a military weapons system.

Not Mission Capable Both (NMCB): Not mission capable for maintenance and supply reasons (Department of the Air Force, 2009).

Not Mission Capable Supply (NMCS): Not mission capable for supply reasons (Department of the Air Force, 2009).

Total Charge Cost: The transaction extended costs the customer was charged (AFTOC, 2008).

Total Charge Quantity: The total number charged to the customer (AFTOC, 2008).

Total Not Mission Capable for Supply (TNMCS): Percentage of unit possessed (reported) aircraft unable to meet primary assigned missions for supply reasons (Department of the Air Force, 2009).

Utilization Rate (UTE Rate): Average number of sorties or hours flown per primary assigned aircraft per period. Usually the time-period is based on a monthly rate.

Appendix B: Performance Indicators

Leading Indicators:

- Ground abort rate
- Air abort rate
- MAF total air abort rate (home station air aborts + J diverts)
- Code 3 break rate
- 4-/8-/12-hour fix rate
- Repeat rate
- Recur rate
- Logistics departure reliability (LDR)
- Average deferred/delayed discrepancies per aircraft
- Discrepancies awaiting maintenance (AWM) or awaiting parts (AWP)
- MSE rate
- Functional check flight (FCF) release rate
- CANN rate
- Issue effectiveness rate
- Stockage effectiveness rate
- Bench-stockage effectiveness rate
- Mission capability (MICAP) aircraft part rate
- Average repair cycle days
- Phase flow—a phase time distribution interval (TDI)

Lagging Indicators:

- AA–aircraft availability rate
- MC–mission capable rate
- FMC–fully mission capable rate
- PMC–partially mission capable rate
- PMCS–PMC for supply rate
- PMCM–PMC for maintenance rate
- PMCB–PMC for both maintenance and supply rate
- NMCM (U/S)–not MC for maintenance, unscheduled or scheduled, rate
- NMCS–not MC for supply rate
- NMCB (U/S)–not MC for maintenance and supply, unscheduled or scheduled, rate
- TNMCM–total not MC for maintenance (NMCM + NMCB) rate
- TNMCS–total not MC for supply (NMCS + NMCB) rate
- UPNR-unit possessed not reported

Appendix C: Simulation Model Data (Parson, 2010)

FSC	Title
1280	Aircraft Bombing Fire Control Components
1560	Airframe Structural Components
1630	Aircraft Wheel and Brake Systems
1650	Aircraft Hydraulic, Vacuum and De-icing System Components
1660	Aircraft Air Conditioning, Heat and Pressurizing Equipment
1680	Miscellaneous Aircraft Accessories and Components
2620	Tires and Tubes, Pneumatic, Aircraft
2835	Gas Turbines, Jet Engine and Components, Except Aircraft
2915	Engine Fuel Systems Components, Aircraft
2995	Miscellaneous Engine Accessories, Aircraft
3120	Bearings, Plain, Unmounted
4730	Fittings and Specialties; Hose, Pipe and Tube
4810	Valves, Powered
5305	Screws
5306	Bolts
5310	Nuts and Washers
5330	Packing and Gasket Materials
5331	O-Rings
5841	Radar Equipment, Airborne
5865	Elect Countermeasures, Counter Countermeasures and Quick Reaction Capability Equipment
5895	Miscellaneous Communication Equipment
5935	Connectors, Electrical
5985	Antennas, Waveguides, Related Equipment
6110	Electrical Control Equipment
6150	Miscellaneous Elect Power and Distribution Equipment
6220	Electric Vehicle Lights, Fixtures
6605	Navigational Instruments
6610	Flight Instruments
6615	Auto Pilot Mechanisms and Airborne Gyro Components
6620	Engine Instruments
6680	Liquid, Gas Flow, Liquid Level and Mechanisms Motion Measuring Instruments
6685	Pressure, Temp, and Humidity Measurement and Control Instruments

Appendix D: Simulation Model Output (Parson, 2010)

Number of Backorders			
FSC	**LB (20%)**	**Mean**	**UB (80%)**
1280	9.56	10.01	10.46
1560	20.02	20.59	21.16
1630	28.35	29.00	29.65
1650	17.23	17.75	18.27
1660	8.88	9.25	9.62
1680	47.17	48.07	48.97
2620	12.79	13.25	13.71
2835	4.62	4.93	5.24
2915	4.52	4.81	5.10
2995	5.97	6.30	6.63
3120	103.80	105.12	106.44
4730	6.20	6.52	6.84
4810	7.21	7.57	7.93
5305	9.70	10.18	10.66
5306	7.86	8.21	8.56
5310	8.94	9.32	9.70
5330	9.48	9.93	10.38
5331	10.68	11.09	11.50
5841	19.38	19.91	20.44
5865	28.90	29.54	30.18
5895	7.48	7.81	8.14
5935	9.42	9.78	10.14
5985	10.93	11.38	11.83
6110	5.80	6.11	6.42
6150	5.46	5.79	6.12
6220	6.00	6.38	6.76
6605	8.13	8.49	8.85
6610	34.01	34.82	35.63
6615	23.89	24.57	25.25
6620	10.59	11.04	11.49
6680	6.73	7.06	7.39
6685	5.63	5.95	6.27

Average MICAP Hours			
FSC	**LB (20%)**	**Mean**	**UB (80%)**
1280	116.66	138.10	159.54
1560	130.41	202.53	235.23
1630	105.17	136.65	146.49
1650	164.75	180.79	186.76
1660	86.43	131.45	143.46
1680	54.00	54.00	54.00
2620	187.19	198.04	203.98
2835	137.58	184.34	199.88
2915	175.49	184.72	192.38
2995	68.78	123.76	136.78
3120	169.54	172.74	175.65
4730	58.81	160.92	189.83
4810	177.66	202.10	210.12
5305	191.18	207.29	214.99
5306	132.76	167.75	178.89
5310	111.91	140.43	150.71
5330	105.71	151.97	165.93
5331	191.47	207.67	214.80
5841	105.48	148.04	161.79
5865	117.55	138.12	146.88
5895	190.66	213.19	221.86
5935	81.54	116.38	126.73
5985	73.13	135.42	150.91
6110	40.77	135.02	164.61
6150	156.43	196.02	211.76
6220	132.94	175.34	191.24
6605	176.70	195.90	203.32
6610	96.54	129.16	137.61
6615	98.45	139.75	151.30
6620	67.82	136.02	152.79
6680	66.94	121.53	135.71
6685	51.54	132.81	154.77

Appendix E: Cost Data

Table E1. USAF Weighted Inflation Indices

OPR: SAF / FMCEE

Date of OSD Inflation Rates: 15-Dec-10

Date of SAF/FMCEE Issue: 14-Jan-11

USAF Weighted Inflation Indices
Based on OSD Raw Inflation Rates
Base Year (FY) 2010

Fiscal Year	Operations & Maint. (3400)	Research, Develop., Testing, Evaluation (3600)	Military Construct. AF (3300)	Military Construct. Guard (3830)	Military Construct. Reserve (3730)	Aircraft Procurement Special (3010)	Aircraft Procurement Other (3010)	Missile Procurement Special (3020)	Missile Procurement Other (3020)	Other Procurement Special (3080)	Other Procurement Other (3080)
2005	0.922	0.914	0.940	0.943	0.940	0.949	0.932	0.916	0.924	0.910	0.914
2006	0.945	0.941	0.964	0.967	0.964	0.973	0.956	0.941	0.950	0.938	0.941
2007	0.969	0.966	0.984	0.984	0.983	0.995	0.981	0.972	0.974	0.962	0.964
2008	0.987	0.985	0.998	0.997	0.996	1.008	0.996	0.989	0.991	0.983	0.984
2009	0.999	0.998	1.009	1.008	1.009	1.024	1.011	0.997	1.004	0.996	0.997
2010	1.010	1.008	1.025	1.021	1.023	1.036	1.026	1.011	1.018	1.005	1.008

Note: 'Special' appropriations refer to programs classified as secret.

TABLE USE:

Weighted indices are used to convert constant dollars to then year dollars, and vice versa.
Use raw indices to convert constant dollars in one year to constant dollars in another year.
Weighted indices for each appropriation are based on outlay rates for TOA excluding pay and POL and should be used accordingly. For Pay and POL, use raw indices.

Table E2. Unit Cost Data in Constant Dollars (FY10) by FSC

FSC	Lower Bound (20%)	Mean	Upper Bound (80%)
5305	$4.05	$4.34	$4.64
5331	$4.46	$4.82	$5.18
5310	$4.71	$5.23	$5.76
5306	$19.20	$21.29	$23.37
5935	$18.91	$25.65	$32.39
5330	$25.02	$28.13	$31.23
4730	$87.83	$98.18	$108.53
3120	$104.63	$125.78	$146.94
2620	$1,224.85	$1,280.84	$1,336.84
6685	$1,368.55	$1,587.54	$1,806.53
6150	$1,687.67	$1,973.44	$2,259.21
1660	$3,212.07	$3,802.28	$4,392.50
6220	$3,943.05	$4,491.78	$5,040.50
6680	$4,334.69	$4,904.45	$5,474.20
6110	$4,018.34	$5,063.99	$6,109.65
1630	$5,996.52	$7,247.00	$8,497.48
1680	$6,633.33	$7,481.58	$8,329.82
2995	$7,863.38	$8,885.64	$9,907.90
4810	$9,835.61	$10,839.50	$11,843.38
6620	$10,807.84	$12,676.74	$14,545.64
1650	$12,243.41	$14,731.02	$17,218.63
1560	$13,422.84	$15,164.41	$16,905.97
2915	$14,334.92	$16,001.02	$17,667.13
6610	$14,396.88	$16,766.77	$19,136.67
1280	$17,989.57	$20,316.92	$22,644.26
6615	$23,848.99	$27,378.47	$30,907.94
5985	$25,999.71	$29,926.50	$33,853.29
5841	$31,610.43	$35,990.61	$40,370.79
5895	$33,028.59	$37,634.52	$42,240.45
6605	$44,109.44	$52,686.13	$61,262.82
2835	$74,563.38	$85,344.23	$96,125.09
5865	$109,572.75	$125,177.33	$140,781.92

Appendix F: Unit Cost, Average Cost per MICAP Hour Comparison

Unit Cost Data in Constant Dollars (FY10)		Cost per MICAP Hour		
FSC	**Mean**	**FSC**	**Mean**	
5305	$4.34	5305	$0.02	**Low Range**
5331	$4.82	5331	$0.02	
5310	$5.23	5310	$0.04	
5306	$21.29	5306	$0.13	
5935	$25.65	5330	$0.19	
5330	$28.13	5935	$0.22	
4730	$98.18	4730	$0.61	
3120	$125.78	3120	$0.73	
2620	$1,280.84	2620	$6.47	**Mid Range**
6685	$1,587.54	6150	$10.07	
6150	$1,973.44	6685	$11.95	
1660	$3,802.28	6220	$25.62	
6220	$4,491.78	1660	$28.93	
6680	$4,904.45	6110	$37.51	
6110	$5,063.99	6680	$40.36	
1630	$7,247.00	1630	$53.03	
1680	$7,481.58	4810	$53.64	
2995	$8,885.64	2995	$71.80	
4810	$10,839.50	1560	$74.88	
6620	$12,676.74	1650	$81.48	
1650	$14,731.02	2915	$86.62	
1560	$15,164.41	6620	$93.20	
2915	$16,001.02	6610	$129.82	**High Range**
6610	$16,766.77	1680	$138.55	
1280	$20,316.92	1280	$147.12	
6615	$27,378.47	5895	$176.53	
5985	$29,926.50	6615	$195.91	
5841	$35,990.61	5985	$220.99	
5895	$37,634.52	5841	$243.11	
6605	$52,686.13	6605	$268.94	
2835	$85,344.23	2835	$462.97	
5865	$125,177.33	5865	$906.32	

Appendix G: Blue Dart

The use of a cost effectiveness methodology to evaluate inventory procurement strategies can provide added insight into the best possible use of limited financial resources. This research utilized a cost effectiveness approach to evaluate the procurement of B-1B bomber spare parts used for base-level maintenance operations. The average number of backorders and average MICAP hours data for 32 Federal Supply Class (FSC) categories were drawn from an Arena simulation model based on historical supply and maintenance data from Ellsworth Air Force Base, along with corresponding cost data from the Air Force Total Ownership Cost database. With this data, the cost per average MICAP hour for each FSC was analyzed to gain insight into which FSCs are most likely to positively influence MICAP hour reductions in a cost effective manner.

An analysis of alternative procurement methodologies demonstrated the benefits of utilizing a strategy that targets incremental procurement of spare parts starting with the lowest cost per MICAP hour. This cost per MICAP hour approach provided the greatest benefit as a result of efficiently allocating resources (mainly appropriated funds) toward FSCs that have the greatest influence on MICAP hours. This appraoch provides an alternative method to execute funding in a cost effective manner with the added insight into how the execution of funding can improve the stockage of parts most likely to reduce MICAP hours and improve aircraft availability.

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Vita

Major Ted A. Wahoske graduated from Ripon Senior High School in Ripon, Wisconsin. He entered undergraduate studies at the University of Wisconsin – Oshkosh, Oshkosh, Wisconsin where he graduated with a Bachelor of Business Administration with degrees in Finance and Accounting in Aug 1988. In 2002, Major Wahoske graduated from Central Michigan University with a Master of Science in Administration. He was previously commissioned through Officer Training School at Maxwell Air Force Base, Alabama in 1997.

His first assignment was at Wright-Patterson Air Force Base as a financial management officer assigned to the Subsystem System Program Office in February 1997. In December 1999, he was assigned to the 4th Comptroller Squadron, Seymour Johnson Air Force Base where he served as a financial services officer. From Seymour Johnson, he transferred to Keflavik Naval Air Station for a one-year remote assignment in 2002 where he served at the Comptroller for the 85th Group. This assignment was followed by an overseas long tour at Spangdahlem Air Base and served as the wing budget officer. After three years at Spangdahlem, he entered instructor duty at Maxwell Air Force Base where he taught at the Defense Financial Management and Comptroller School. While assigned to Maxwell, Major Wahoske was selected for squadron command and departed for Dyess Air Force Base to assume command of the 7th Comptroller Squadron in 2008. In 2010, he was selected to attend the Air Force Institute of Technology to complete in-residence Intermediate Developmental Education. Upon graduation, he will be assigned to the Pentagon and will serve as a financial cost analyst.

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